Multi-layered Carbon Foils with Graphite-like properties

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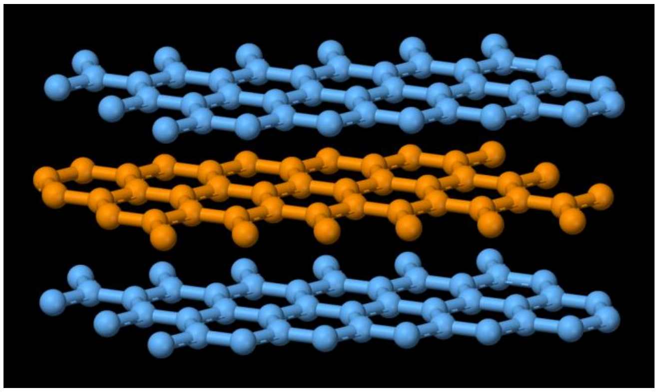
From Wikipedia: "There is a common belief that graphite's lubricating properties are solely due to the loose inter-lamellar coupling between sheets in the structure. **However, it has been shown that in a vacuum environment (such as in technologies for use in space), graphite is a very poor lubricant. This observation led to the discovery that the lubrication is due to the presence of fluids between the layers, such as air and water, which are naturally adsorbed from the environment."**



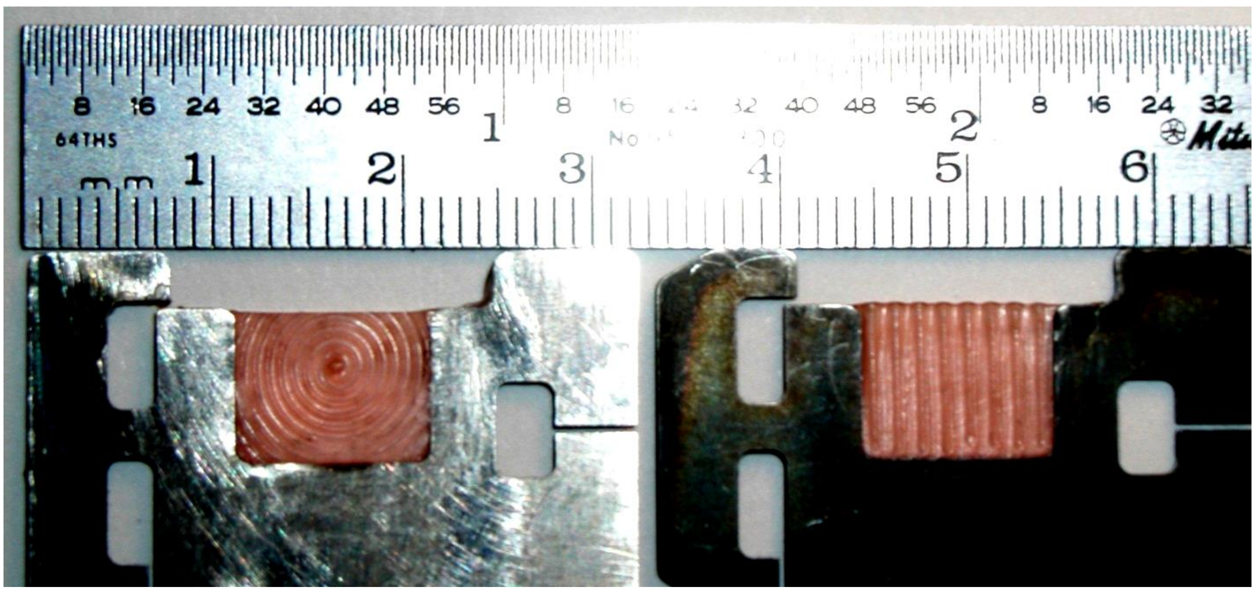
This is a proposal to investigate the creation of layered carbon foils can be made by intentionally interrupting the deposition process and allowing the foils to relax, coating them with a monolayer of another material, heating or cooling them to 'set' the structure and/or exposing the freshly made surfaces to gases or fluids creating a monolayer slip plane between successive carbon layers. The result could be a **graphite-like carbon stripper foil** or a new type of structure.

Investigation of this process could lead to the creation of thin carbon foils with *slip planes* for differential contraction and expansion during beam heating. This process could also relax surface tension between the substrate and the successive layers of the foil helping to avoid curling and unpredictable stretching, folding, and tearing during extreme heating and radiation damage.

When used in combination with textured removable substrates [see below], carbon stripper foils may be made with extended lifetimes as a result of their ability to 'adapt' to beam conditions, foil ablation, and erosion. This process may also allow us to control the surface properties of the foil such as emissivity. With a reproducible surface structure that is not dependent on random folding and shaping found in conventional carbon foils, we will be able to determine real time temperatures of the foil by remote optical and

infrared systems. This will give us the ability to design foils for specific beam conditions and evaluate lifetimes of foils for future use in high intensity beams such as those in FRIB.

Proposed method of creating controlled textured carbon foils using removable surface templates

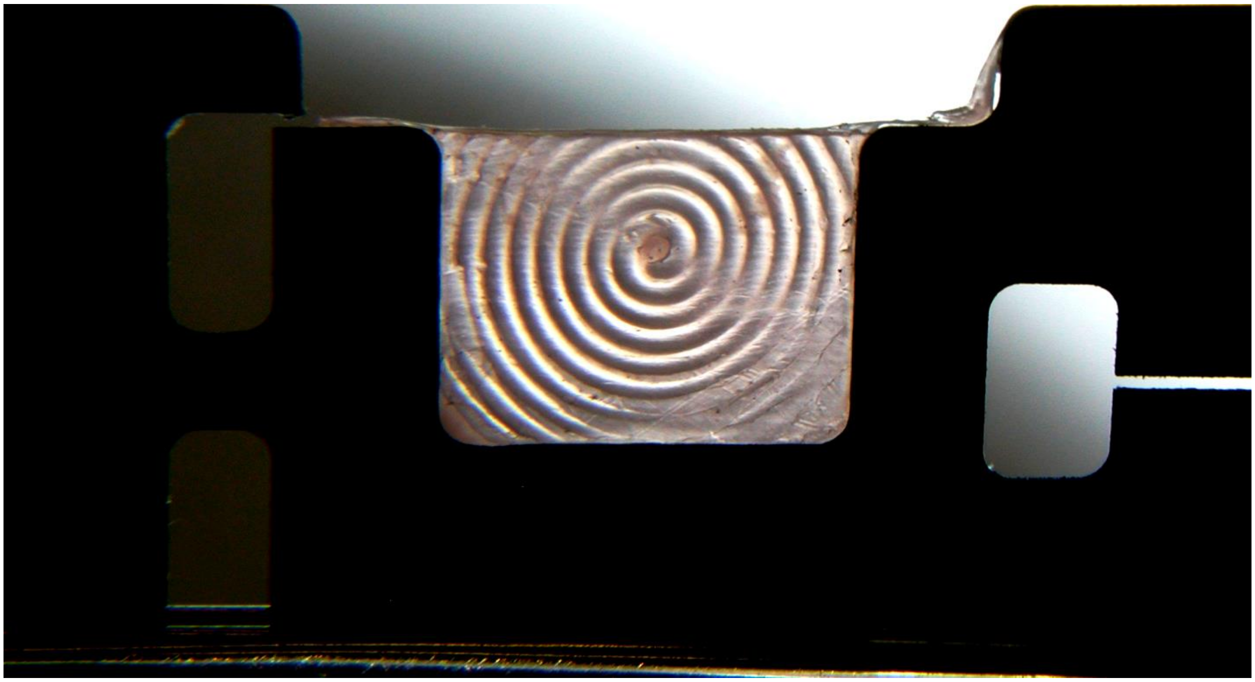


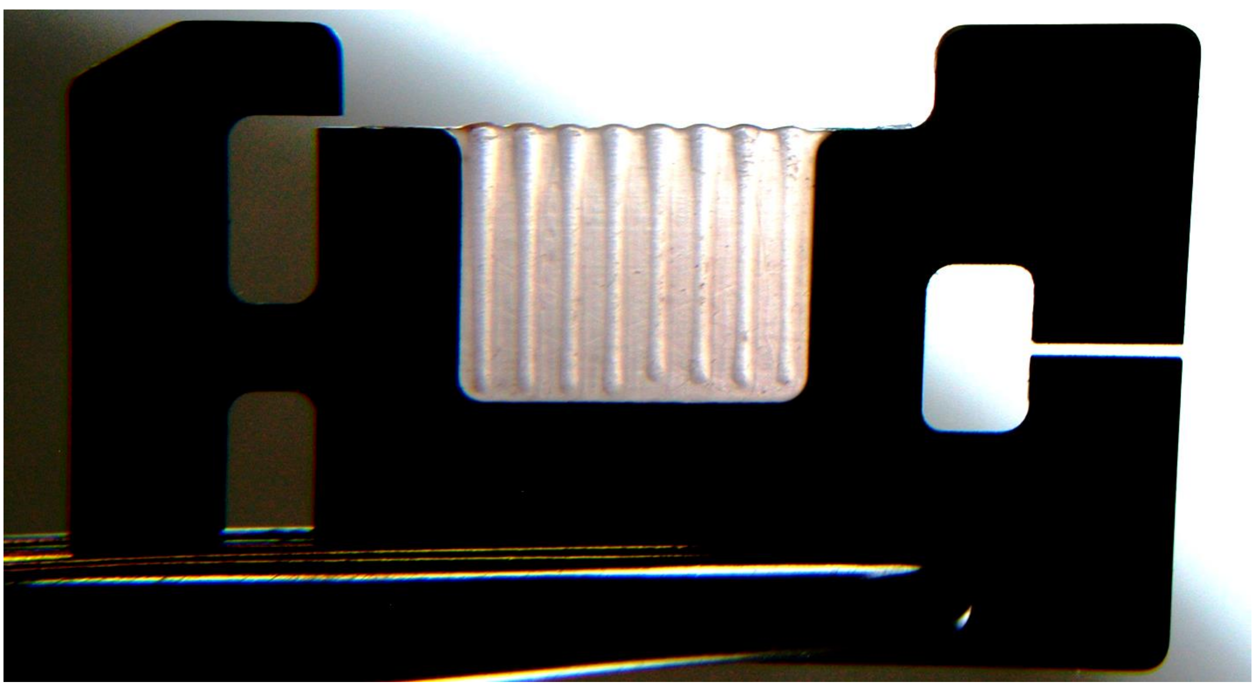
Carbon and other foils can be directly coated onto holders with removable textured substrates as indicated in the photographs. The author has successfully done this with microcrystalline jewelers wax molded into the target holder for both carbon and cracked ethylene foils of thicknesses from 200 to 600 microgram/cm2 in a vacuum deposition system.

The foil holders and wax substrates are mounted on a water cooled plate or other heat sink to keep the wax from melting during deposition of the thin foil. After deposition, the wax is removed by dissolving it in a gently heated container with cyclohexane or other appropriate solvent in a vapor hood. The author accomplished proof of principle tests some 26 years ago showing that this method works.

The direct deposition of the foil onto its support frame has many advantages including strong adherence to the frame without the need for glues. The textured substrates create foils that can expand and contract uniformly with heating by particle beams. The photograph above shows two possible textured surfaces prior to carbon coating – a spiral and linear corrugation.

In the photographs below the textured patterns are seen more clearly. In the authors tests there were no discontinuities in the foil at the target to wax interface.





It is proposed that a dedicated carbon coating system be acquired to develop this technique further to investigate the geometric parameters in foil shape in order to optimize foil lifetimes in high intensity beams in the CCF and for FRIB.